

## T15D12 – Entropy IB Practice MS

1. B
2. A
3. A
4. (i) fertilizers/increasing crop yields;  
production of explosives for mining; 1 max
- (ii)  $\Delta H = (\text{sum of energies of bonds broken}) - (\text{sum of energies of bonds formed})$ ;  
*Can be implied by working.*  
correct substitution of values and numbers of bonds broken;  
correct substitution of values and numbers of bonds made;  
 $(\Delta H = (\text{N}(\text{triple})\text{N}) + 3(\text{H}-\text{H}) - 6(\text{N}-\text{H}) = 944 + 3(436) - 6(388) = -76.0 \text{ (kJ)};$  4  
*Allow ECF.*  
*Do not penalize for sig. fig. or units.*  
*Award [4] for correct final answer.*
- (iii)  $(\Delta S^\ominus [2 \times 193] - [192 + 3 \times 131]) = -199 \text{ (J K}^{-1} \text{ mol}^{-1})$ ; 2  
*Allow ECF.*  
*four gaseous molecules generating two gaseous molecules/fewer molecules of gas;*
- (iv)  $(\Delta G^\ominus = \Delta H^\ominus - T\Delta S^\ominus = -76.0 - 298(-0.199)) = -16.7 \text{ (kJ)};$   
Spontaneous;  
 $\Delta G$  is negative; 3  
*Do not penalize for SF.*
- (v) heat released when gas  $\rightarrow$  liquid;  
 $\Delta H^\ominus$  becomes more negative; 2
5. (a)  $\text{C}_6\text{H}_{12} + 9\text{O}_2 \rightarrow 6\text{CO}_2 + 6\text{H}_2\text{O};$  1
- (b) (i)  $(\Delta H^\ominus = \sum \Delta H_{\text{f}}^\ominus \text{ products} - \sum \Delta H_{\text{f}}^\ominus \text{ reactants})$   
 $\Delta H^\ominus = (6 \times -394 + 6 \times -242) - (-43);$   
 $\Delta H_{\text{c}}^\ominus = -3773 / -3.8 \times 10^3 \text{ (kJ mol}^{-1}\text{)};$  2  
*Accept 2, 3 or 4 sig. fig..*  
*Award [1] for  $+3773 / +3.8 \times 10^3 \text{ (kJ mol}^{-1}\text{)}.$*   
*Allow ECF from (a) only if coefficients used.*
- (ii)  $\Delta S^\ominus = (S_{\text{p}}^\ominus - S_{\text{r}}^\ominus) = (6 \times 189 + 6 \times 214) - (385 + 9 \times 205);$   
 $\Delta S^\ominus = 188 \text{ (J K}^{-1} \text{ mol}^{-1}\text{)};$  2  
*Accept only 3 sig. fig..*  
*Award [1] for -188.*  
*Allow ECF from (a) only if coefficients used.*
- (c)  $(\Delta G_{\text{c}}^\ominus = \Delta H_{\text{c}}^\ominus - T\Delta S_{\text{c}}^\ominus) = -3800 - (298 \times 0.188);$   
 $= -3900 \text{ kJ mol}^{-1}.$  2  
*Accept -3800 to -3900.*  
*Accept 2, 3 or 4 sig. fig.*  
*Allow ECF from (b).*  
*Units needed for second mark.*
- (d) spontaneous and  $\Delta G^\ominus$  negative; 1  
*Allow ECF from (c).*

[12]

[8]



6. (a)  $\Delta S = \Delta S^\ominus$  (products) -  $\Delta S^\ominus$  (reactants)/suitable cycle;  
= 270 - 248 - 2x131;  
= - 240 (J K<sup>-1</sup>); 3  
*Units not needed for mark, but penalize incorrect units.*  
*Award [3] for correct final answer.*
- (b)  $\Delta G^\ominus = - 287 - (298 \times -0.240)$ ;  
*Award [1] for correct substitution of values and [1] for conversion of units.*  
= -215 kJ; 3  
*Units needed for mark.*  
*Apply ECF from - 360 kJ or incorrect answer from (a).*

**[6]**